Utility of Balloon-Assisted Guglielmi Detachable Coiling in the Treatment of Cerebral Aneurysms

A Single Center Retrospective Study

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Summary

Balloon-assisted Guglielmi detachable coiling (BAGDC) is a new technical option developed to allow endovascular treatment of wide-necked aneurysms. Aim of the following work is to report a single center experience of BADGC of aneurysms with assessment of its efficacy and safety.

BAGDC of wide-necked aneurysms (SNR close to 1) was retrospectively evaluated in 37 patients (28 females, nine males, mean age: 56.6 yrs, range: 27-81 yrs) who underwent the procedure between january 1999 and january 2002 for a total of 45 procedures on 41 aneurysms. Twenty-nine patients presented with SAH from an acutely ruptured aneurysm.

In two patients BAGDC failed whereas 35 patients successfully underwent BADGC (39 aneurysms). Twenty-nine patients (31 aneurysms) were available for angiographic follow-up (mean: 10 mo, range: 3-24 mo). At the last angiographic follow-up 29/33 aneurysms (87%) resulted stable and occluded (22 aneurysms with dense and seven with loose packing of the sac and the neck), two aneurysms showed regrowth, one aneurysm showed a neck remnant and another one a sac and neck remnant. Complications directly related to the procedure occurred in five patients (three perforations, one thromboembolism, one femoral AV) with a mortality and morbility rate of 2.7 and 5.4 respectively.

BAGDC is a promising adjunct to treatment of wide-necked aneurysms broadening the spectrum of indications for endovascular treament of challenging aneurysms.

Introduction

Endovascular treatment of intracranial aneurysms by deployment of Guglielmi detechable coils (GDC) within the aneurysmal lumen until complete obliteration and exclusion is a well-known and important alternative to surgical clipping [1-3]. One major limitation of conventional aneurysm coiling is represented by a wide neck providing less support for coil retention within the aneurysm. Therefore dense packing of wide-necked aneurysms while maintaining parent vessel patency still represents one of the major challenges because of the risk of coil migration or protrusion [4]. This leads to loose packing, coil compaction and multiple coiling sessions. Ballon assisted Guglielmi Detachable Coiling (BAGDC) of wide-necked aneurysms provides a new technical option. The technique was first described by J. Moret et Al with the name of "remodeling " because it allows remodeling of the aneurysmal neck by temporarily inflating a nondetachable balloon in front of the aneurysmal base during coil deposition [5,6]. The objective of the following work was to report a single center experience on the efficacy and safety of BAGDC of intracranial aneurysms in a series of patients with follow-up.

Patients and Methods

Patient population

Thirty-seven consecutive patients (28 females, nine males, mean age: 56.6 yrs, range: 27-81 yrs) underwent BAGDC of intracranial aneurysms between january 1999 and january 2002 at the Neuroradiology Unit of Careggi Hospital (A.O.C.). All patients were treated by two experienced interventional neuroradiologists (S.M. and G.V.). Clinical data and angiograms were reviewed by two neuroradiologists (S.M. and M.C.) working together in session. Twenty-nine patients presented with subarachnoid haemorrhage (SAH) caused by aneurysmal rupture and a Hunt and Hess grading of I (nr = 2), II (nr = 12), III (nr = 11), IV (nr = 4). Two patients presented with visual disturbances secondary to optic nerve compression from multiple aneurysms (ipsilateral carotid-ophthalmic and cavernous tract of the carotid syphon in one patient and bilateral internal carotid bifurcation in the other). One patient with a left superior hypophyseal artery aneurysm presented with headache and diplopia from ipsilateral third nerve palsy. Five patients had occasionally discovered aneurysms; one of these had two unruptured aneurysms and one had a pial arteriovenous malformation in another vascular territory. Overall 12 patients had multiple aneurysms. In six patients harbouring multiple aneurysms BADGC was used for one aneurysm and surgical clipping was performed for the other one in a different session before (nr = 1) or after (nr = 5) the endovascular procedure. In three patients, BAGDC was used for one aneurysm and conventional coiling was used for the other one in the same session. In three other patients, all aneurysms were treated by BAGDC in the same (nr = 2) or a subsequent (nr = 1) session. In seven patients, focal (nr = 5) or diffuse (nr = 2) vasospasm was present at the beginning of the procedure. Seven patients had already received either conventional coiling (nr = 5) or surgical clipping (nr = 2) of the same aneurysm.

The location of BAGDC-treated aneurysms was as follows: paraclinoid internal carotid / carotid-ophthalmic arteries: 14, posterior communicating artery: 12, internal carotid artery bifurcation: five, basilar artery tip: four, anterior communicating artery: two, superior cerebellar artery: one, carotid-cave: one, anterior choroidal artery: one, middle cerebral artery (M1): one. Overall 41 aneurysms were treated with BAGDC. Four patients with aneurysmal remnants and/or regrowths were retreated by BAGDC for a total of 45 procedures (the second procedure on the same aneurysm was considered a new procedure). Thirty-four aneurysms had a "small" diameter sac and seven had a "large" diameter sac. A "small" diameter aneurysm was defined as having a fundus 12 mm or less in diameter; a "large" aneurysm was defined as having a fundus diameter between 12 and 25 mm. Overall 21 aneurysms had a diameter of 10 mm or greater. All treated aneurysms were wide-necked defined as having a neck diameter 3 mm or greater or a sack -to-neck ratio (SNR) close to 1.

Endovascular treatment

The BAGDC technique was employed either after conventional endovascular treatment had failed or from the beginning whenever it was deemed inappropriate on the basis of the SNR, aneurysm morphology and its relationship with respect to parent vessel anatomy. All procedures were performed in an angiographic suite equipped with digital subtraction angiography and roadmapping capabilities.

The procedures were performed under general anesthesia. In all patients systemic anticoagulation (intravenous bolus of heparin 3000-5000 IU followed by infusion of 3000 IU/h) was administered as soon as the introducer sheath was inserted in the case of unruptured aneurysms and after placement of the first coil in case of ruptured aneurysms. The general procedure of BAGDC has been described previously [5,6]. In the postoperative period, heparin infusion was maintained (1000 IU/hr) for 48-72 h followed by a low-molecular heparin treatment. A 6 Fr femoral sheath was introduced into each femoral artery followed by positioning of two guiding catheters (Envoy 6 and 5 Fr). First, a nondetachable balloon (Solstice or Equinox) was advanced through the 5 Fr guiding catheter to the neck of the aneurysm.

The microcatheter was then advanced through the 6 Fr controlateral guiding catheter to the parent vessel and into the aneurysm sac. Finally, the balloon was temporarily inflated so as to occlude the parent artery at the base of the aneurysm during coil deposition through the tip of the microcatheter. Before detachment of each coil the balloon was carefully deflated so that the stability of the coil mass within the aneurysm was assessed. If the coil was stable, the latter was electrolytically detached. The aneurysm was classified as completely occluded (100%) if the sac and neck were densely packed, subtotally occluded (90-95%) if the sack was loosely packed but the aneurysm was excluded, incompletely occluded (< 90%) in the case of a residual neck or aneurysm. In all patients, a postprocedural CT examination of the head was obtained as a routine baseline study. In 14 cases, the postprocedural CT demonstrated areas of high attenuation in the cortical or deep vascular territory of the parent vessel. In all cases, such cortical areas had density characteristics incompatible with blood (much higher than blood) and disappeared on the control CT 24-48 hours later. In 29 patients an angiographic follow-up was obtained (mean: 10 mo, range: 3-24 mo). The last angiographic control was performed three to eight months later in 19 patients, 12 to 18 months later in eight patients, 24 later months in two patients. In eight patients, it was not possible to obtain a follow-up because of either patient refusal /unavailability (nr = 4) or intercurrent death (nr = 2) or BADGC failure (nr = 2).Clinical follow-up was obtained during clinical appointment or by phone interviews.

Results

Treatment feasibility

In three cases, embolization failed because it was not possible to appropriately place the microballoon in front of the neck of the aneurysm due to cervical vessel tortuosity (nr = 2) or coil instability within the aneurysmal sac after balloon deflation (nr = 1). In one case, successful BAGDC of the aneurysm was performed in a subsequent session after direct common carotid artery puncture. In both remaining cases the patients underwent a successful surgical clipping.

Efficacy

At the end of the procedure, occlusion was considered complete (dense packing) in 28/39 aneurysms (71%), subtotal (loose packing) in 9/39 aneurysms (23%), incomplete with residual neck (2%) in one aneurysm and incomplete with residual aneurysm (2%) in another aneurysm. Three patients died: one because of massive subarachnoid rebleeding from a totally excluded aneurysm 12 hours later and the other two from diffuse vasospasm and acute renal failure 15 days and six months later respectively. In five out of 37 aneurysms (13.5%), early angiographic follow-up (3-6 mo) demonstrated recanalization of the aneurysmal neck and/or sac.

Four recurrent aneurysms had original dimensions equal or larger than 10 mm and in two cases they were of the terminal type, one was an anterior communicanting aneurysm. Four aneurysms were retreated by remodeling and one with stenting and coiling. Of the initial 39 aneurysms (35 patients) treated by BAGDC, 33 aneurysms (29 patients) were available for follow-up. At the last control angiography, 29/33 aneurysms (87%) resulted stable and occluded (22 with dense and six with loose packing of the aneurysmal sac and neck), two out of 33 (6%) aneurysms showed regrowth, one out of 33 aneurysm (3%) showed a neck remnant and one aneurysm a sac and neck remnant.

Complications

Complications that could be directly related to the treatment occurred in six patients. In three patients harbouring an acutely (within 24-28 hrs) ruptured aneurysm, inadvertent perforation of the aneurysmal sac by the microguide (nr = 1) or the coils (nr = 2) caused intraoperative subarachnoid bleeding. Prompt inflation of the balloon already positioned in front of the aneurysmal neck with temporary occlusion of the parent vessel, heparin reversal and concomitant deployment of GDC within the aneurysmal sac staunched the bleeding. At the end of the procedure, two patients did not experience a worsening of clinical conditions and one patient, admitted with a HH grading 3 SAH progressed to HH 4-5 and at follow-up 18 months later he was chronically instituzionalized. One patient experienced a thromboembolic occlusion of parietal branches of the ipsi-

A B C D

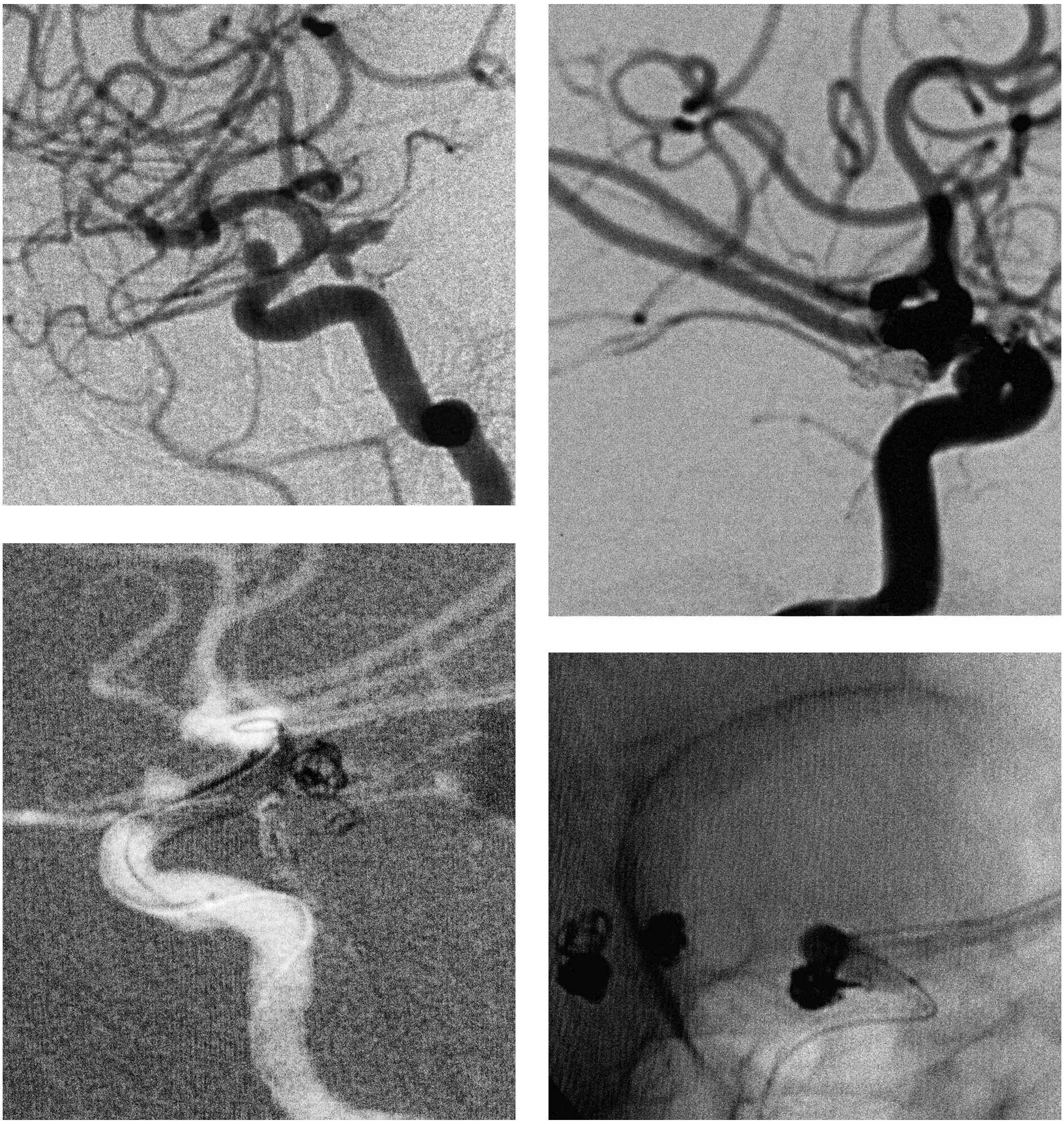


Figure 1 Twenty-seven year-old male with SAH (II HH grading). The diagnostic angiographic study (A-B) shows 3 aneurysms: a carotid-ophthalmic and a posterior communicating (pcom) aneurysms on the right and a carotid-cave aneurysm on the left. The pcom aneurysm shows an irregular bilobed profile and was acutely treated whereas the right carotid-ophthalmic and left carotid-cave aneurysms were subsequently treated in the same session one month later. The roadmap image (C) during "remodeling" of the right pcom aneurysm shows a spiral loop projecting outside the aneurysmal sac due to perforation. Note the contrast level in the interpeduncular cistern and the inflated balloon at the base of the aneurysm temporarily occluding the parent vessel. Unsubtracted image (D) shows the microballon inflated at the base of the left carotid-cave aneurysm and the microcatheter positioned inside the aneurysmal sac. The follow-up angiographic study 6 months later (E-F) shows a stable occlusion of all aneurysms.

lateral middle cerebral artery at the final angiographic runs after complete aneurysm coiling. Hyperselective infusion of Urokinase (400.000 IU) allowed partial recanalization of the occluded vessels and upon waking the patient experienced a transitory (few minutes) left hemiparesis. One patient died 12 hours after the procedure from massive subarachnoid rebleeding. A femoral AV fistula was reported in one other patient.

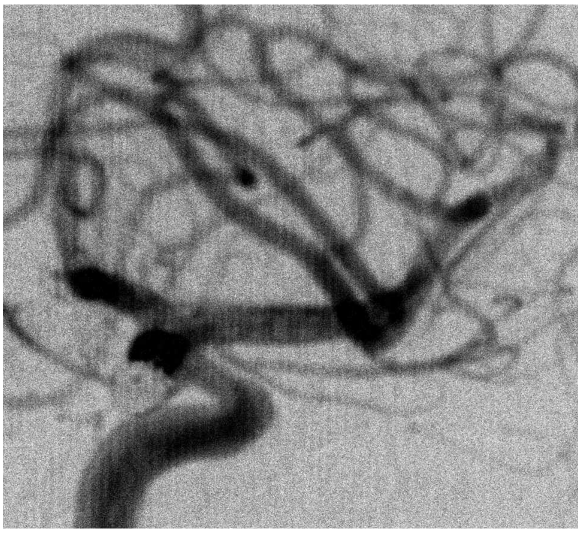
Complications that could not be directly related to the procedure occurred in three other patients. In one patient, a transitory episode of aphasia occurred a week after discontinuation of antiplatelet therapy by the family doctor and resolved without clinical consequences. Two patients had an intracerebral (basal ganglia) hematoma after a systemic hypertensive crisis one and seven days later respectively and one of them necessitated surgical evacuation. In one of these patients, epistaxis was also reported.

Discussion

The use of a temporarily inflated balloon in front of the aneurysmal neck during coiling serves two purposes: first it stabilizes the microcatheter tip in the aneurysmal sac during coil delivery, second it forces the coil to assume the shape of the aneurysmal neck without impingement or protrusion in the parent vessel. In our series, this technique also resulted in more dense packing and successful treatment of aneurysms that were not previously amenable to endovascular therapy broadening the indications of endovascular treatment of intracranial aneurysms.

The balloon employed in our study was an over-the-wire silicon balloon that allowed accurate and stable positioning across the neck of the aneurysm in most cases and only in one case was a direct carotid puncture performed to allow a stable positioning of both the balloon and the microcatheter. In our experience, it was extremely important to place the balloon properly so that the inflow zone of the aneurysm neck is occluded while maintaining a portion of the outflow zone. This allows a balance of intra-aneurysmal pressures during coil deployment. It can be hazardous to perform the opposite, that is to occlude the outflow zone while maintaining some filling of the aneurysm. This may create a situation where there is inflow but not outflow which could certainly lead to rupture even without coil deployment. A longer balloon (15 mm) may solve this problem completely occluding the aneurysmal neck while maintaining a stable positioning throughout the procedure. On the other hand, multiple inflations/deflations of the microballoon may cause a stress force at the base of the aneurysm. This may have been the cause of neck rupture with fatal rebleeding in one of our patients 12 h after complete BAGDC of a large posterior communicating artery aneurysm.

E



F

As regards the choice of coils, we generally favored the use of a 3D coil as the first coil and passed subsequently to deliver softer stretch-resistant coils. This resulted in the formation of a “basket” enabling better filling of the aneurysmal dome and consequently more dense packing and lower chances of recurrency. As last coils we favored ultrasoft coils in order

Table i **Overview of patients**

Patients Nr. sex/age	**Presentation**	**Location and size**	**Complications**	**Enhancement postprocedural CT**	**Clinical outcome**	**Anatomic outcome (length of follow-up)**	**Comments**
1. F 73 yrs	HH II sah	R carotid-ophthalmic Small			Intact	Subtotal 12 mo	Later surgical clipping of a R MCA bifurcation aneurysm
2. M 52 yrs	Deficit visus OD	R ICA bifurcation Large		R silvian	Visual acuity improved from light perception to 20/40	Regrowth 24 mo	Thrombosed giant L ICA bifurcation aneurysm
3. F 56 yrs	Occasional	R Pcom Small			Intact	Complete 24 mo	
4. F 53 yrs	HH III sah	R ICA paraclinoid Small	AV femoral fistula	R silvian	Intact	No follow-up	Prior surgical clipping of a R MCA bifurcation aneurysm
5. M 66 yrs	HH III sah	Basilar tip Small		L posterior temporobasal	Intact	Complete 18 mo	L vert art hypoplasia
6. M 57 yrs	HH III sah	Basilar tip Small		R temporobasal - thalamus	Intact	Complete 18 mo	L vert art ostial stenosis
7. M 77 yrs	HH II sah	R ICA paraclinoid Small	Embolism 7 days later		Intact	No follow-up	
8. F 54 yrs	Deficit visus OS	R carotid-ophthalmic Small	Nasal bleeding		Focal deficit No change from preprocedure	Complete 6 mo	1 L carotid-cavernous giant aneurysm treated endovascularly elsewhere
9. F 64 yrs	HH III sah	R ICA paraclinoid Small			Intact	Failure	BAGDC failure due to coils instability followed by surgical clipping
10. F 49 yrs	HH II sah	Basilar tip Small			Intact	Regrowth 12 mo	Conventional GDC of a R carotid-ophthalmic aneurysm in a # session
11. F 62 yrs	HH IV sah vasospasm	R carotid-ophthalmic Small			Died		
12. M 42 yrs	HH II sah vasospasm	L carotid-ophthalmic Large		L convexity	Intact	Complete 12 mo	Conventional GDC of a L ICA bifurcation aneurysm in the same session and later surgical clipping of a R MCA bifurcation aneurysm
13. F 67 yrs	HH III sah	R Pcom Small		R silvian	Intact	Subtotal 12 mo	
14. F 41 yrs	HH II sah vasospasm	R Pcom Small	Embolism		Baseline focal deficit	Complete 6 mo	Sister treated for cerebral aneurysm
15. F 64 yrs	HH I sah	R ICA paraclinoid Small	ICH 7 days later Nasal bleeding		Intact	Neck and sack remnant 6 mo	Conventional GDC of a L PcomA aneurysm in a # session
16. F 67 yrs	HH III sah	R Pcom Small			Intact	Neck remnant 6 mo	
17. F 45 yrs	HH III sah	L Pcom Large	Perforation + increase of sah		Chronically instituzionalized	Complete 6 mo	Baby aneurysm of the choroidal artery
18. F 35 yrs	HH II sah vasospasm	L Pcom Small		L silvian-basal ganglia	Intact	Complete 6 mo	Mother with aneurysm
19. F 42 yrs	HH II sah vasospasm	L Pcom Large	Massive sah 12 h late		Died		Died (aneurysmal neck rupture)
20. F 47 yrs	HH III sah vasospasm	R Pcom Small			Baseline focal deficit	Complete 12 mo	
21. F 65 yrs	III c.n. deficit	L ICA bifurcation Small		L basal ganglia	Baseline focal deficit	Subtotal 6 mo	Two BAGDC of the same aneurysm in # consecutive session. Later surgical clipping of a R MCA bifurcation aneurysm

Patients Nr. sex/age	Presentation	Location and size	Complications	Enhancement postprocedural CT	Clinical outcome	Anatomic outcome (length of follow-up)	Comments
22. F 73 yrs	HH III sah	L Pcom Large	ICH 24 h later	L convexity	Intact	Complete 7 mo	Unsuccessful BAGDC followed by stenting and coiling of the same aneurysm in a # session
23. M 53 yrs	Occasional	Acom Small			Intact	Failure	BAGDC failure followed by successful surgical clipping
24. M 55 yrs	HH I sah vasospasm	L carotid-ophthalmic Small		L frontal	Intact	Complete 12 mo	Successful BAGDC of a postsurgical residual neck
25. M 27 yrs	HH II sah	R carotid-ophthalmic Small R Pcom Small L carotid-cave Small	Perforation + slight increase of sah	R silvian-basal ganglia	Intact	Complete Complete Complete 6 mo	All aneurysms treated by BAGDC in two # consecutive sessions
26. M 39 yrs	HH II sah	Acom Small			Intact	Complete 8 mo	Prior unsuccessful surgical clipping followed by conventional GDC and BAGDC of the same aneurysm in two # consecutive session
27. F 67 yrs	HH IV sah + hematoma	R MCA (M1) Large		R insular	Focal deficit	Subtotal 6 mo	Parenchymal hematoma surgically drained after embolization
28. F 53 yrs	HH III sah	L Pcom Small			Intact	Complete 8 mo	First BAGDC failed due to vessel tortuosity followed by successful BADGC after direct carotid puncture in a # session
29. F 39 yrs	Occasional	L carotid-ophthalmic Large			Intact	Complete 3 mo	
30. F 65 yrs	HH II sah	R Ant. Choroidal Small			Intact	No follow-up	
31. F 60 yrs	Occasional	R carotid-ophthalmic Small			Intact	Complete 6 mo	
32. F 81 yrs	HH III sah	R Pcom Small			Intact	No follow-up	
33. M 43 yrs	HH II sah	Basilar tip Small			Intact	Complete 8 mo	
34. F 60 yrs	HH IV sah	R ICA bifurcation Small	Perforation + slight sah		Mild cognitive deterioration	Complete 7 mo	
35. F 56 yrs	Occasional	R ICA bifurcation Small R carotid-ophthalmic Small		R basal ganglia	Intact	Complete Subtotal 4 mo	Two BAGDC of # aneurysms in the same session. Later surgical clipping of a R MCA bifurcation aneurysm
36. F 74 yrs	HH II sah	R ICA bifurcation Small		enh	Intact	Complete 2 mo	Two BAGDC of the same aneurysm in # consecutive session Died of renal failure
37. F 56 yrs	HH IV sah	L carotid-ophthalmic Small L sup. Cerebellar Small		enh II emb	Cognitive deterioration Subtotal 6 mo	Complete	Two BAGDC of # aneurysms in # sessions. Both received a prior conventionalGDC treatment

to decrease the stress on the mesh and allow a better remodeling of the neck with more dense packing of the sac. Whenever a protrusion of a loop of the coil was observed in the parent vessel we abstained from balloon inflation. The coil was immediately withdrawn and redeployed only after balloon inflation. This avoided a dangerous increase in the intra-aneurysmal coil mesh pressure leading possibly to aneurysmal rupture.

Our experience stresses the importance of placing first the microballoon in front of the aneurysm neck and then advancing the microcatheter through the controlateral sheath into the aneurysm dome. Manipulation of the microcatheter and balloon in this manner stops the microcatheter tip jumping forward as the balloon catheter is advanced to the neck of the aneurysm. Furthermore, this manipulation helped to staunch a bleed from inadvertent microguide-induced aneurysmal perforation by a prompt inflation of the microballoon and occlusion of the parent vessel at the aneurysmal neck.

There are some notable differences and similarities between this study and previously reported series [6-8]. Similarly to the series reported by Lefkowitz, the aneurysms treated in this study were larger than those reported by Moret: 51% of aneurysms in our study were larger than 10 mm as opposed to 23% of Moret and 57% of Lefkowitz. The angiographic rate (67%) for complete occlusion (dense packing of aneurysmal sack and neck) in our series was similar to previous results published by Moret (61%) and Cottier (67%) and slightly inferior to those reported by Lefkowitz (83%). The number of subtotally or incompletely treated aneurysms in our series could be ascribed to the high percentage (78%) of ruptured aneurysms as opposed to 21% and 61% in the series of Lefkowitz and Cottier respectively. Since the wall of an acutely ruptured aneurysm may be more fragile than that of an unruptured one and overpacking may cause rebleeding we chose not to pack too densely. Similarly to Lefkowitz and Cottier, 100% of our patients harboured a wide-necked aneurysm as opposed to 52% in the study of Moret. Despite the aforementioned similarities and differences to other studies, the rate of BAGDC (25%) with respect to all the aneurysms endovascularly treated was about the same in the present study compared to Moret (20%) and Lefkowitz (17%). Moreover, in our series there are two cases of intra-periprocedural rupture similarly to Moret and at variance with Lefkowitz and Cottier. This may also be partly explained by the higher number of ruptured aneurysms treated in our series.

Although coil instability before detachment and after balloon deflation is rather infrequent, it occurred once in our series hindering treatment of an anterior communicating aneurysm. Anterior communicating artery aneurysms represent a difficult location for BAGDC [9]. The vessel anatomic configuration is often unfavourable to positioning the microballoon in front of the aneurysmal base. In fact, in this location the balloon usually straddles between the anterior communicating artery and the A2 tract of the anterior cerebral artery incompletely occluding the aneurysmal neck. This may have caused the partial remodeling of the aneurysmal neck with insufficient coil stability in our case.

In our series, 31% of CT scans obtained immediately after completion of the procedure revealed a transitory contrast enhancement of the brain parenchyma in the vascular territory of the parent vessel. This phenomenon is well known to occur [10] and has been reported to be a good prognostic sign after intra-arterial thrombolysis [11]. Since it has not been specifically reported in patients endovascularly treated for cerebral aneurysms, it may go apparently unrecognised or misdiagnosed. In our opinion, this phenomenon may represent a transitory blood-brain barrier disruption secondary to repeated occlusions of the parent vessel from balloon inflation during the BAGDC of the aneurysm. The observation that such abnormal foci of contrast enhancement always occurred in the vascular territory of the parent vessel seems to sustain this hypothesis.

Despite the usefulness of BAGDC in the treatment of wide-necked aneurysms, the technique is not without risks. In addition to the usual risks of conventional GDC treatment, there are extra risks from the use of two microcatheters in the same artery, and temporary occlusion of the parent vessel with repeated inflation-deflation of the balloon. These factors may lead to rupture of the aneurysm neck, ischemia from prolonged vessel occlusion, thrombus formation with distal embolization, dissection, vasospasm, occlusion of perforators and balloon-related endothelial damage leading to possible stenosis or delayed thromboembolisms. It is for these reasons that some authors do not recommend BAGDC of aneurysms as a primary treatment option [7] or suggest it only after conventional treatment has failed [8]. On the other hand, BAGDC entails important advantages over the conventional technique and in our experience intra-periprocedural complications were within the range of conventional endovascular treatment. Moreover, since this experience we have grown more confident in its employment and in our institution preventive positioning of a microballoon in front of the aneurysmal neck has been extended to include cases that would not have been previously treated with this technique from the start. This is mainly conceived to obtain a prompt staunching in case of intraprocedural rupture of the aneurysm. Another possible explanation for intra-periprocedural thromboembolism is that greater exposure of the thrombogenic coils to the bloodstream in case of wide-necked aneurysms may increase the predisposition to intraluminal clot and embolization. Indeed, this may be the explanation for a transitory episode of aphasia in one of our patients seven days after embolization after discontinuation of the medical therapy by the family doctor. Increased use of heparin after the procedure or the use of antiplatelet such as aspirin, tiklid or abciximab may reduce the risk of postprocedural thrombosis. Advances in interventional neuroradiology have led to the development of newer more trackable stents and it is probable that in the near future we will see more stent placements for scaffolding of wide-necked aneurysms rather than the use of the balloon "remodeling" technique. In one of our cases, we successfully adopted a new endovascular intracranial AVE stent in retreating a recurrent large aneurysm of the posterior communicating artery previously treated with BAGDC. Also the development of miniature stents grafts may allow many aneurysms to be treated without coil embolization by merely obliterating flow into the aneurysm. In our series, the mean follow-up was short (10 mo) Larger series with longer follow-up will be necessary to support the long-term efficacy of BAGDC of cerebral aneurysms.

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